Member Organizations

American Association of State Highway and Transportation Officials
Association of Public Safety Communications Officials - International
Forestry Conservation Communications Association
International Association of Chiefs of Police
International Association of Emergency Managers
International Association of Fire Chiefs
International Association of Fish and Wildlife Agencies
International Municipal Signal Association
National Association of State Foresters
National Association of State Telecommunications Directors

Liaison Organizations

Federal Emergency Management Agency • Federal Law Enforcement Wireless Users Group • Public Safety Wireless Network • US Department of Agriculture • US Department of Interior

Docket 00-32

TOPIC:
Mask and OOBE Specification, Adjacent Channel Interference Effects

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National Public Safety Telecommunications Council (NPSTC)
Ex parte Meeting with OET
July 28, 2004

Sean O'Hara – NPSTC Advisor, Syracuse Research Corporation

- **Lets take a look at 802.11a/j and DSRC Adjacent channel performance**
  - **Using receiver performance specifications, i.e. utilization of the Adjacent channel Rejection tables (ACR) in the draft DSRC PHY/MAC Standard (Tables 11 and 12)**
  - **Examine maximum interference level to cause 3 dB degradation to reference sensitivity performance**
  - **"Worst-case", the interferers are operating under Class A Emissions Masks**
  - **Look at keep-away distance from operation at reference sensitivity levels**

Designation: E 2213–02

ENGLISH

Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems — 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications1

This standard is issued under the fixed designation E 2213; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (e) indicates an editorial change since the last revision or

FROM ASTM E 2213–02

8.10.2 Adjacent Channel Rejection

Two categories of adjacent channel rejection capability will be allowed. They are designated as Type 1 and Type 2. The adjacent channel rejection shall be measured by setting the desired signal's strength 3 dB above the rate-dependent sensitivity specified in Table 12[5] and Table 13[5] and raising the power of the interfering signal, until 10 % PER is caused for a PSDU length of 1000 bytes. The power difference between the interfering and the desired channel is the corresponding adjacent channel rejection. ***The interfering signal in the adjacent channel shall be an OFDM signal conforming to a Class A spectral mask****, unsynchronized with the signal in the channel under test. For a compliant OFDM PHY, the corresponding rejection shall be no less than specified in Table 12[5] for a Type 1 device and Table 13[5] for a Type 2 device.*

-Type I Receiver

FROM ASTM E 2213–02

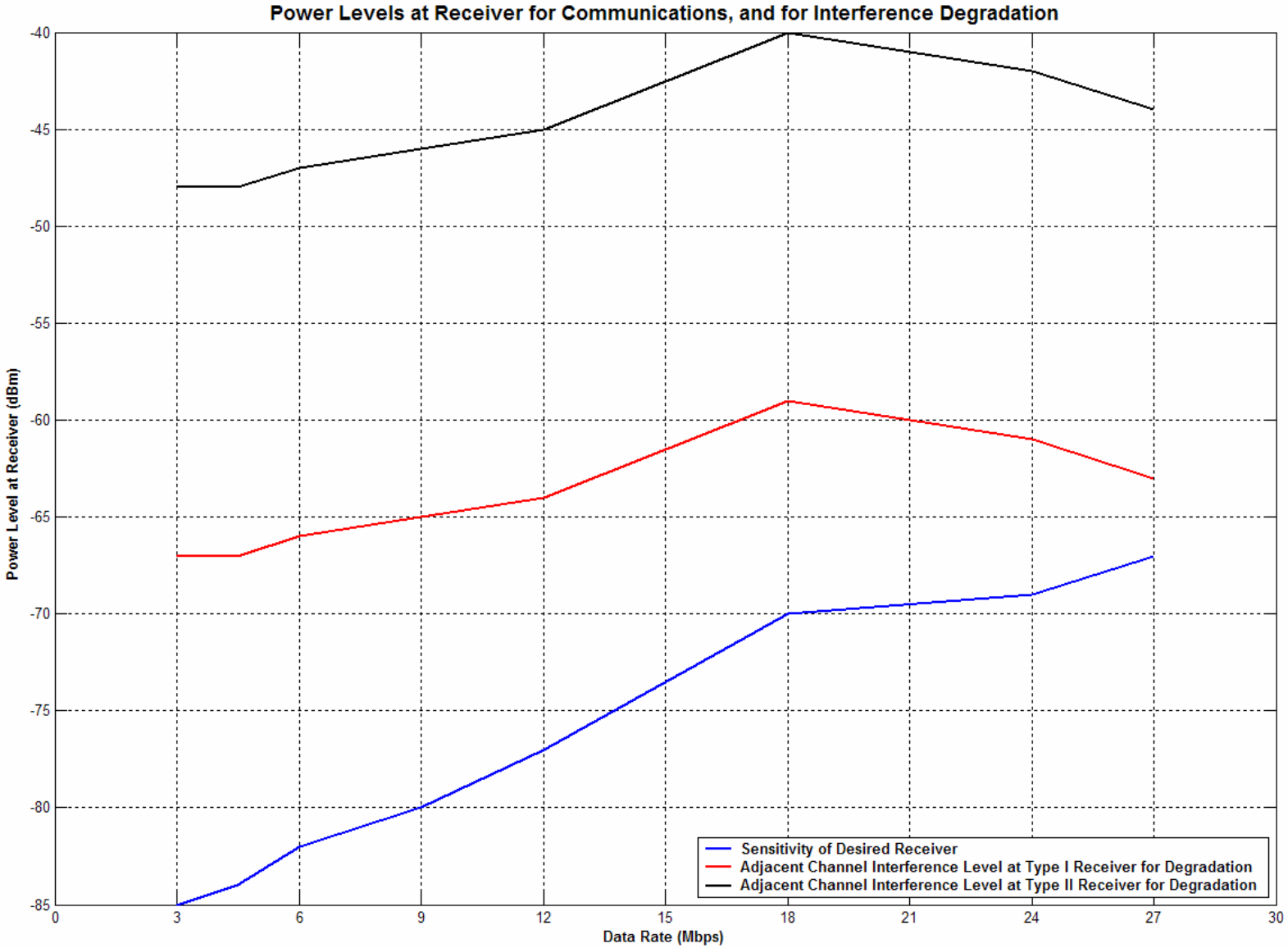
TABLE 12 Type 1 Receiver Performance Requirements A				
Data Rate, Mbits/s	Minimum Sensitivity, dBm	Adjacent Channel Rejection, dB	Alternate Adjacent Channel Rejection, dB	Interferer Level (dBm)
3	-85	18	34	-67
4.5	-84	17	33	-67
6	-82	16	32	-66
9	-80	15	31	-65
12	-77	13	29	-64
18	-70	11	27	-59
24	-69	8	24	-61
27	-67	4	20	-63

-Type II Receiver

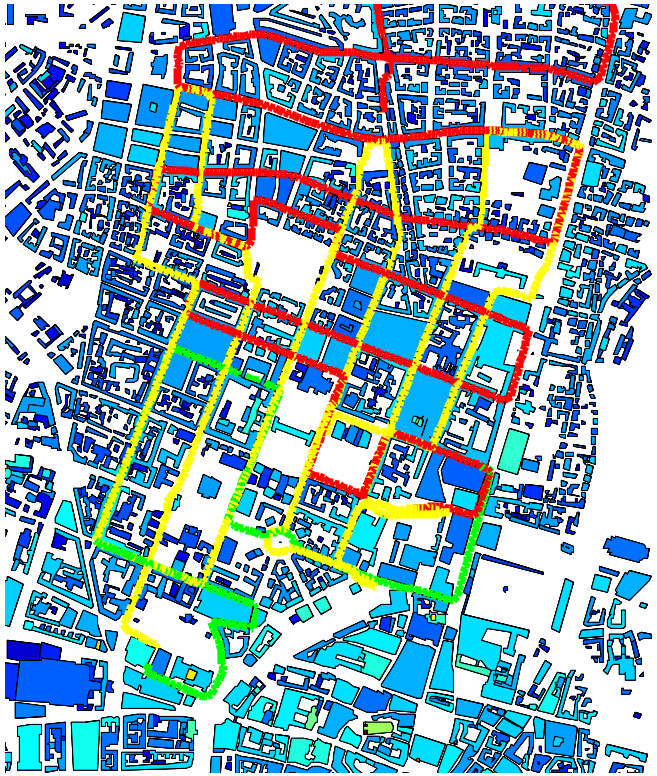
FROM ASTM E 2213–02

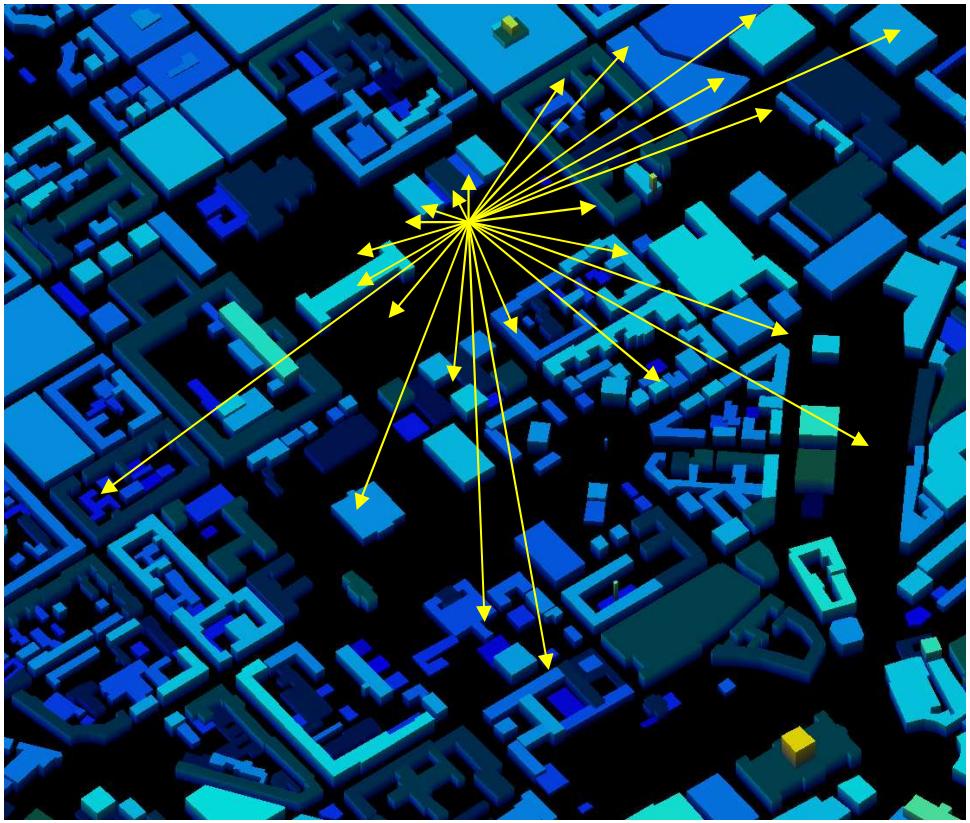
TABLE 13 Type 2 Receiver Performance Requirements A				
Data Rate, Mbits/s	Minimum Sensitivity, dBm	Adjacent Channel Rejection, dB	Alternate Adjacent Channel Rejection, dB	Interferer Level (dBm)
3	-85	37	44	-48
4.5	-84	36	43	-48
6	-82	35	42	-47
9	-80	34	41	-46
12	-77	32	39	-45
18	-70	30	37	-40
24	-69	27	34	-42
27	-67	23	30	-44

Receiver Power Levels for Data Rates and Interference

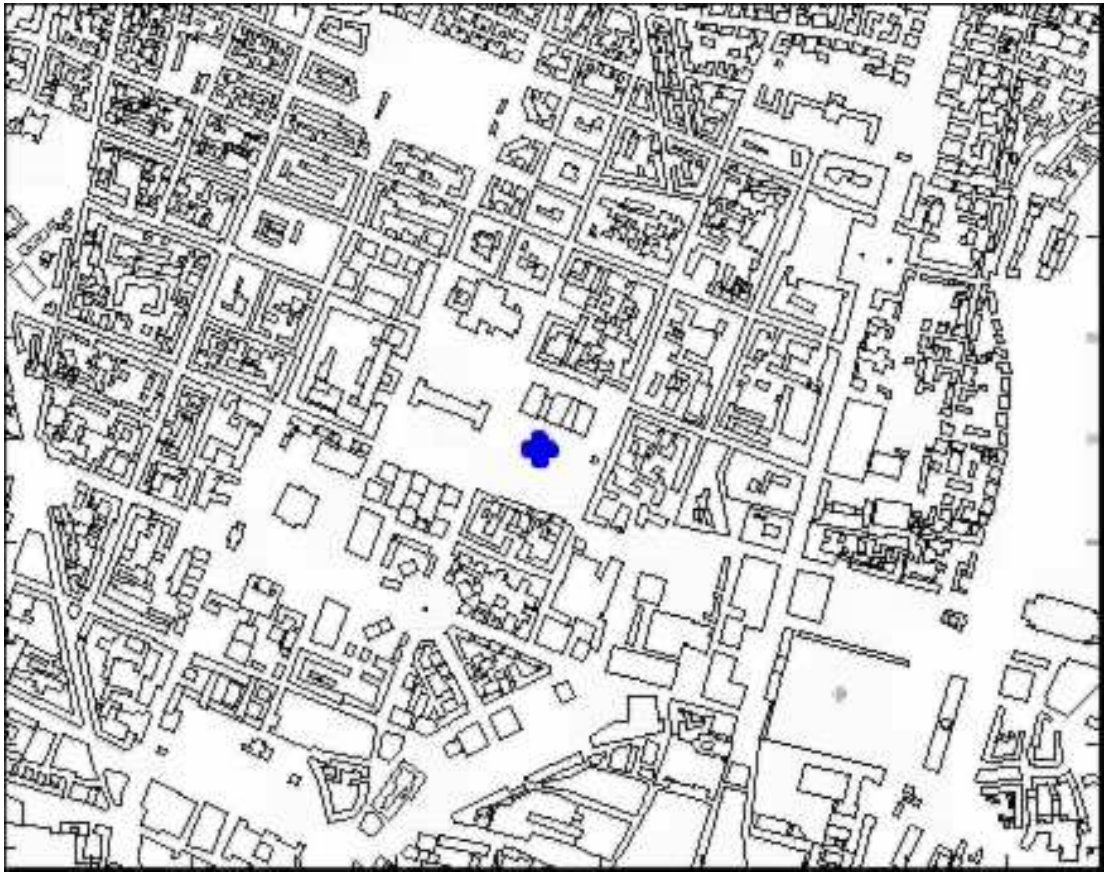


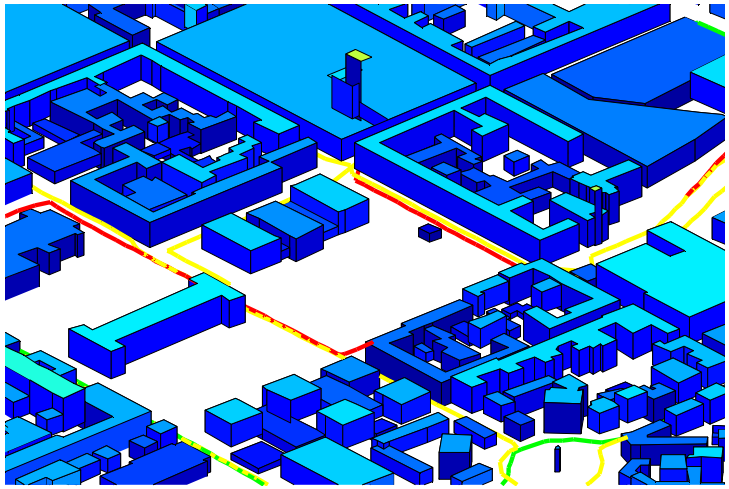
Scattering and Multipath – Essentially LOS for Coverage Range





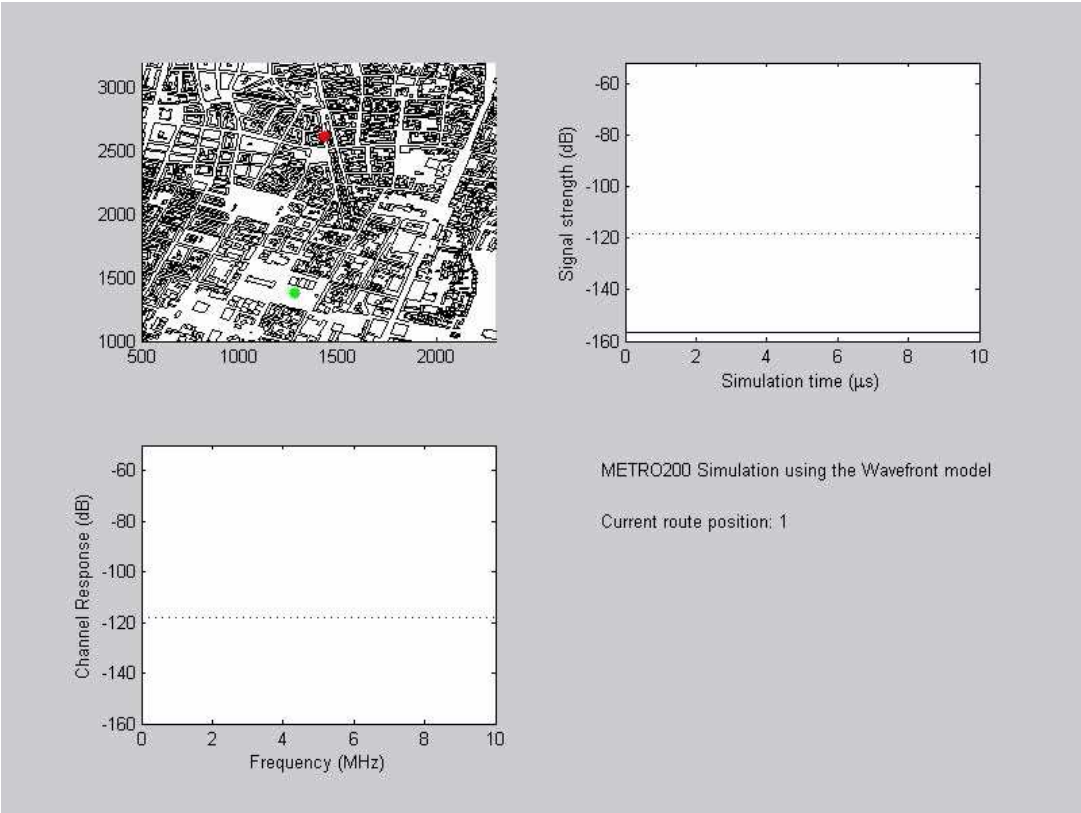
Scattering and Multipath





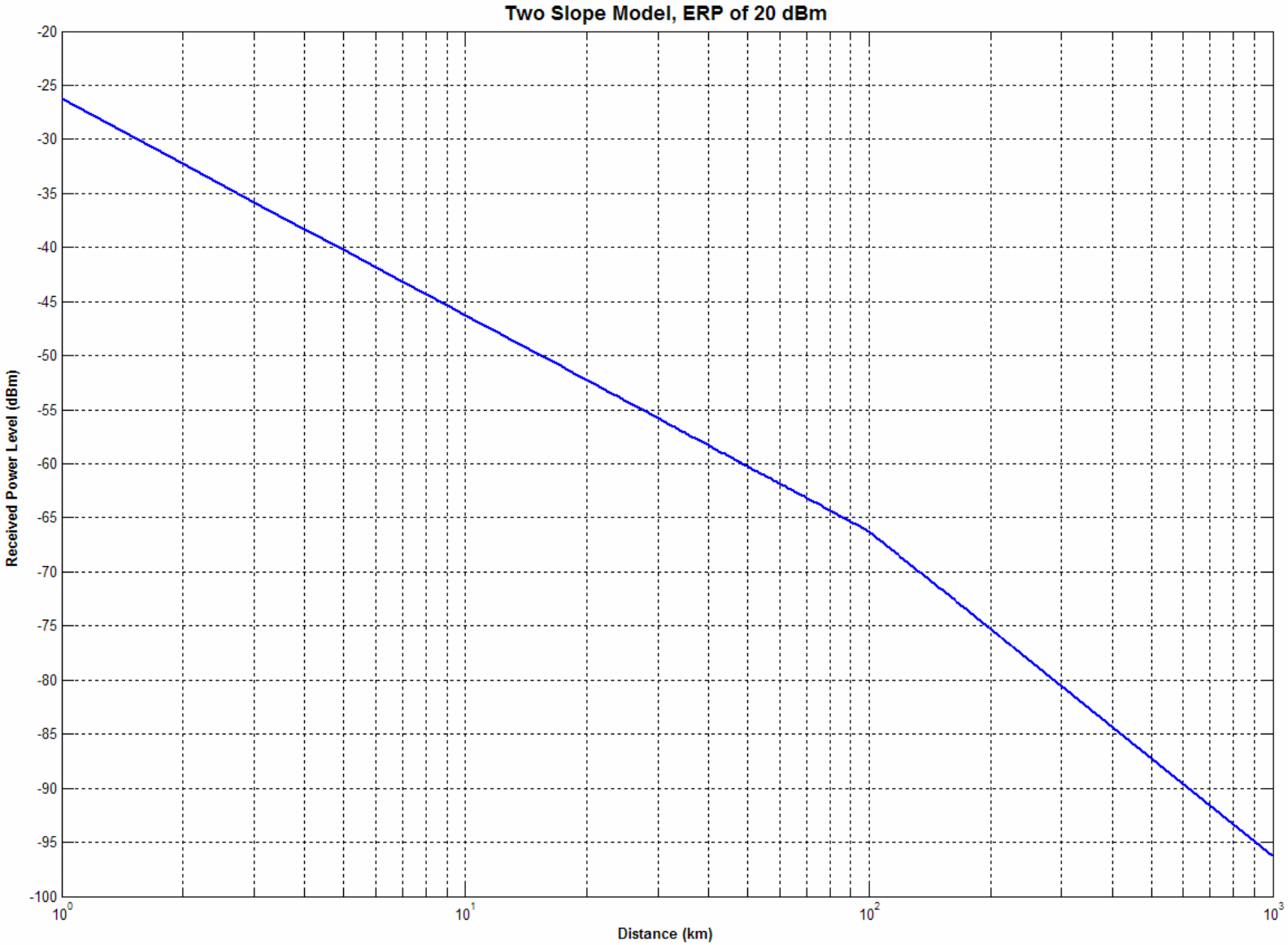
Multipath Fills in Areas,
Two Slope Path Loss Model
Generally Assumed
(Click on Left Figure for
Animation)

Wideband Channel Effects

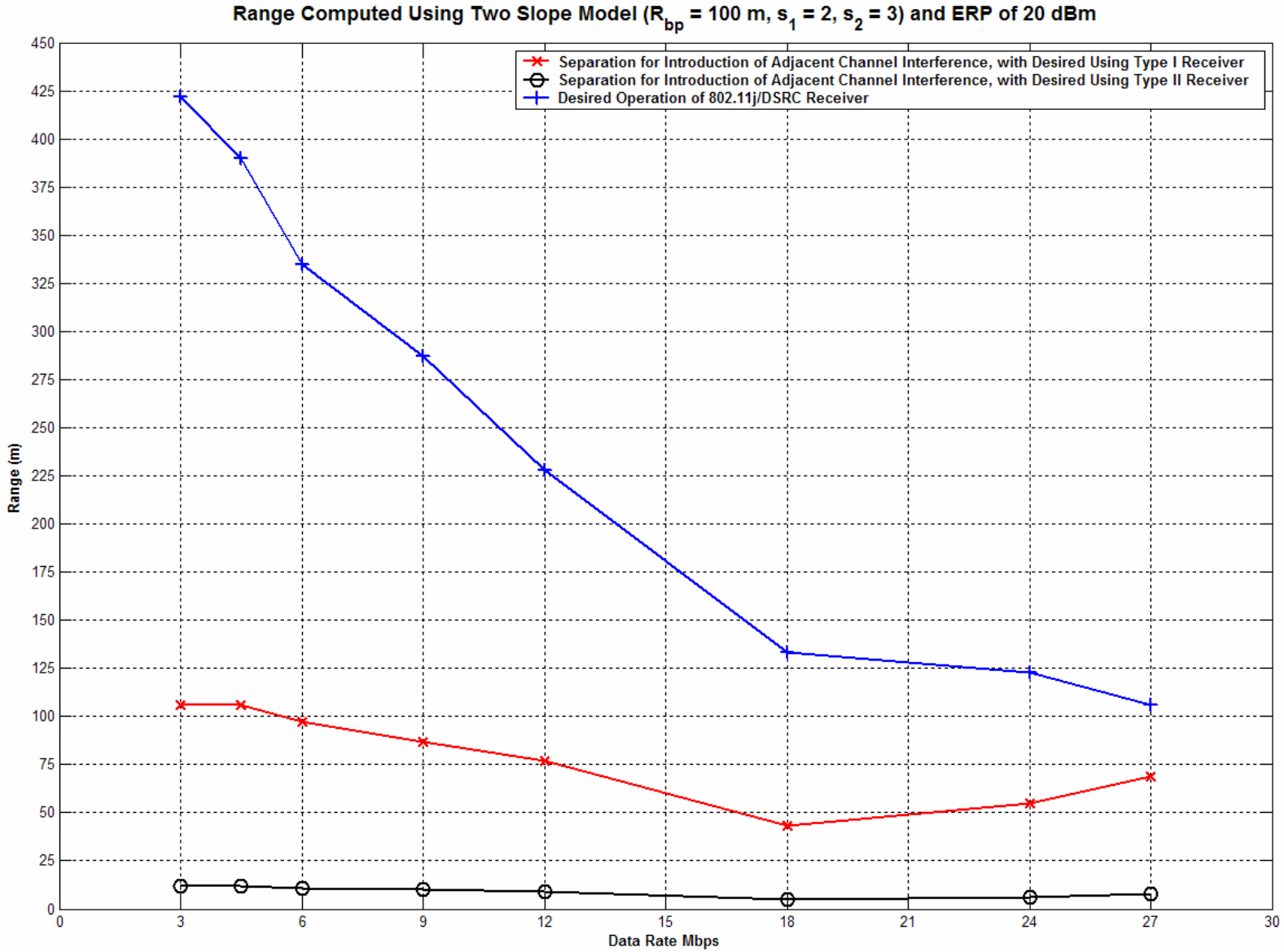


Channel Impulse and Frequency Response is Non-Stationary (Click on Figure for Animation)

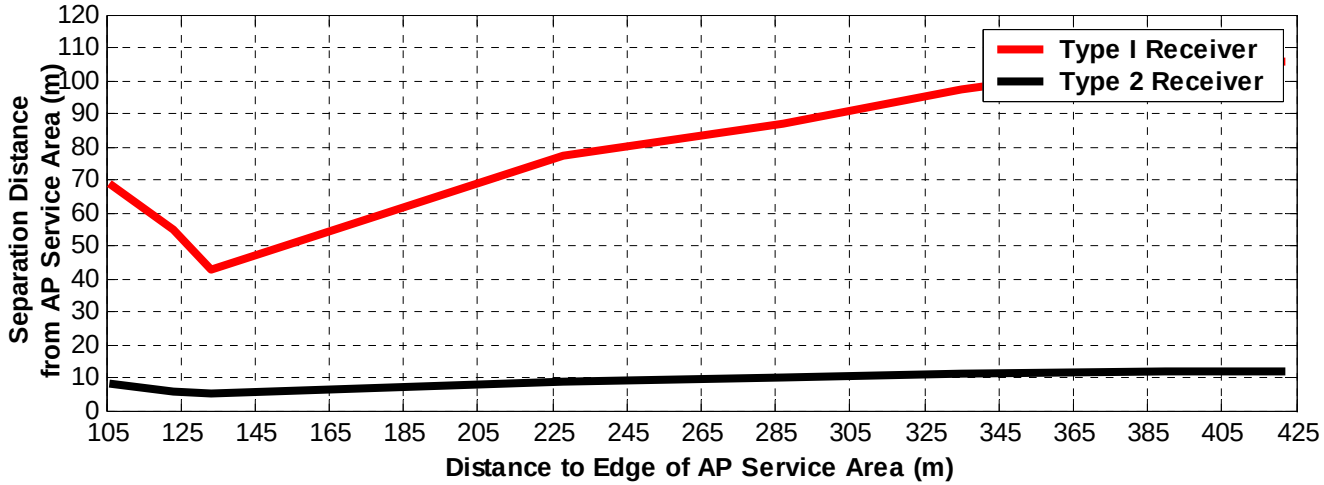
Two-Slope Propagation Model



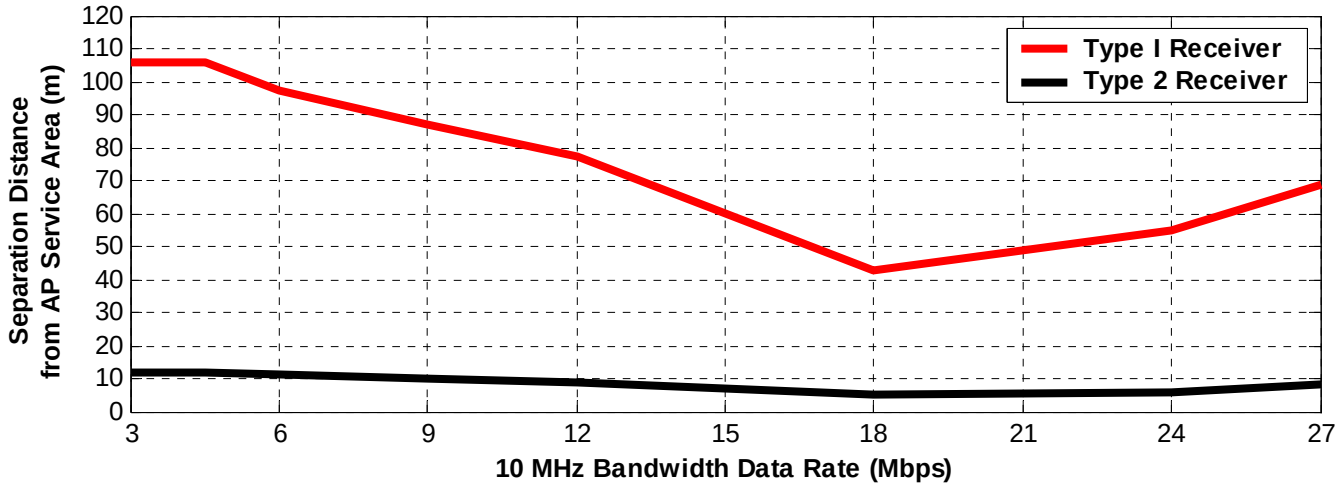
Communications and Interference Ranges



Communications and Interference Ranges

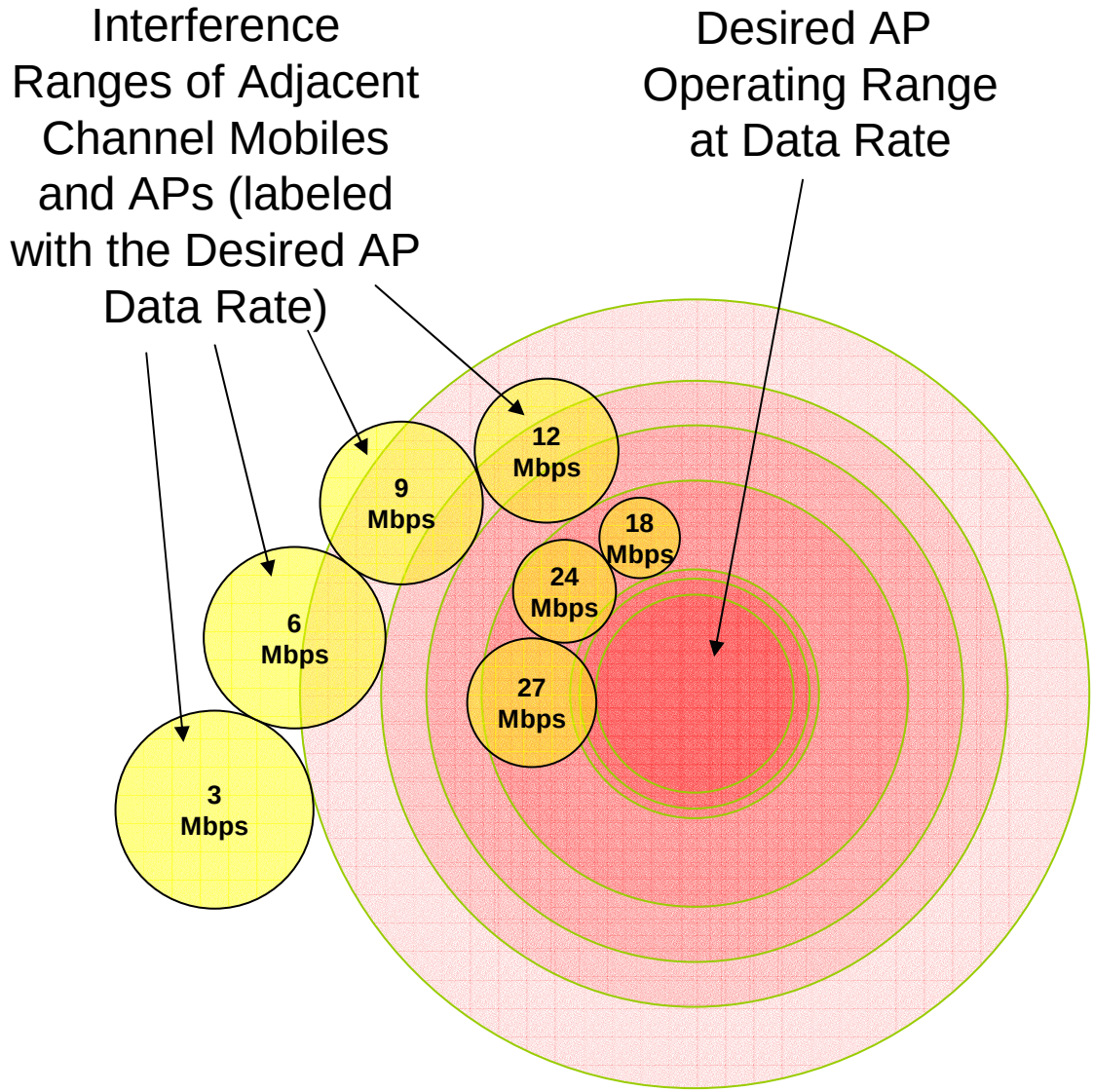


Adjacent Channel Effects Decrease as AP Service Area Decreases



Adjacent Channel Effects Decrease as AP Data Rate Increases

Communications and Interference Ranges



Values are to scale

(Type 1 Receivers)

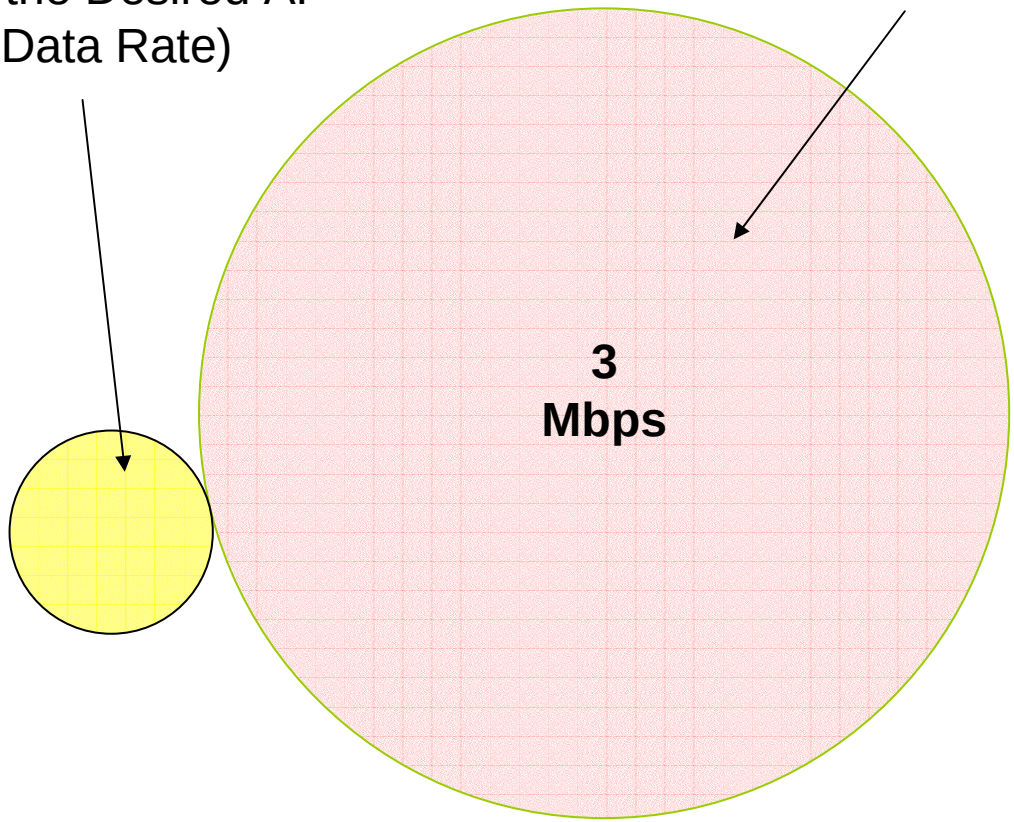
Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

3 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

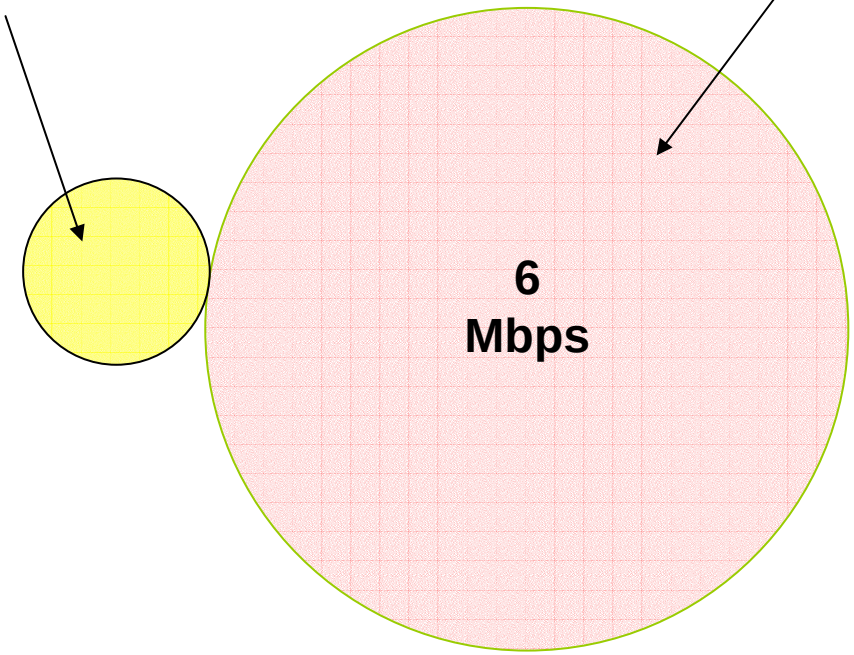
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

6 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

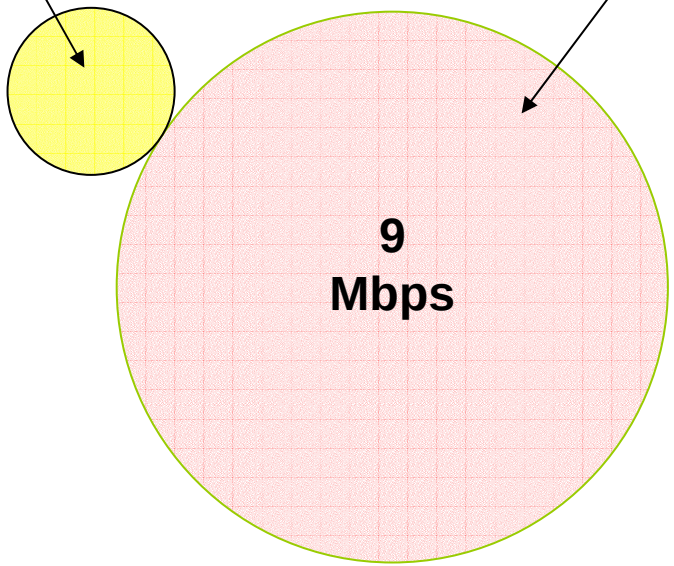
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

9 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

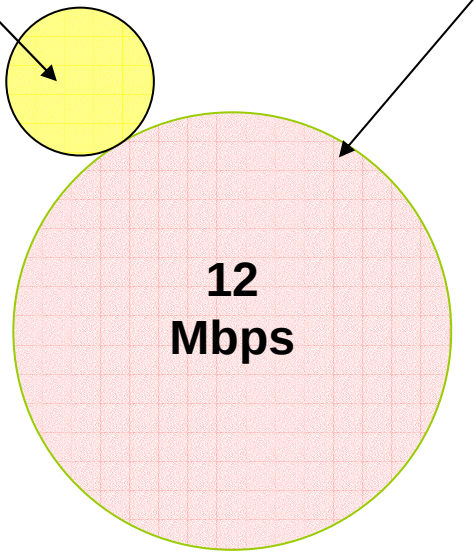
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

12 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

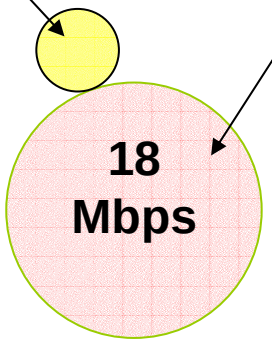
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

18 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

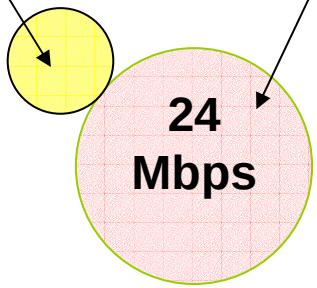
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

24 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate



Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

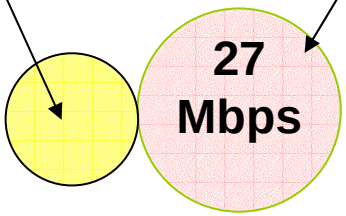
Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

27 Mbps Data Rate (Type 1 Receivers)

Interference Ranges of Adjacent Channel Mobiles and APs (labeled with the Desired AP Data Rate)

Desired AP Operating Range at Data Rate

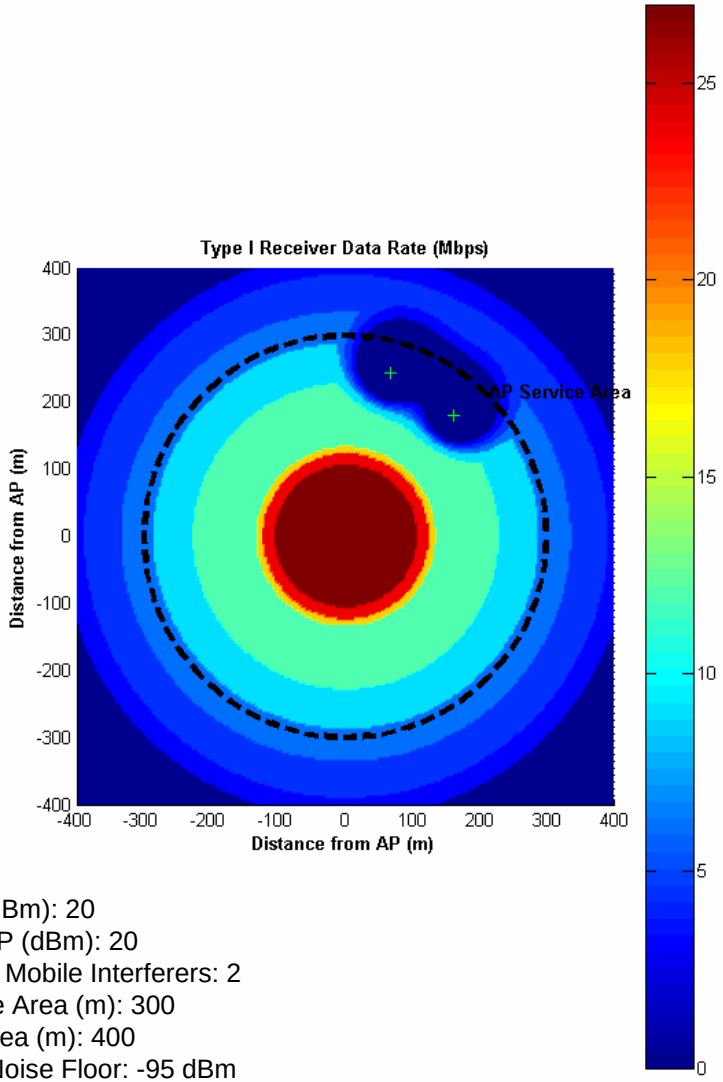


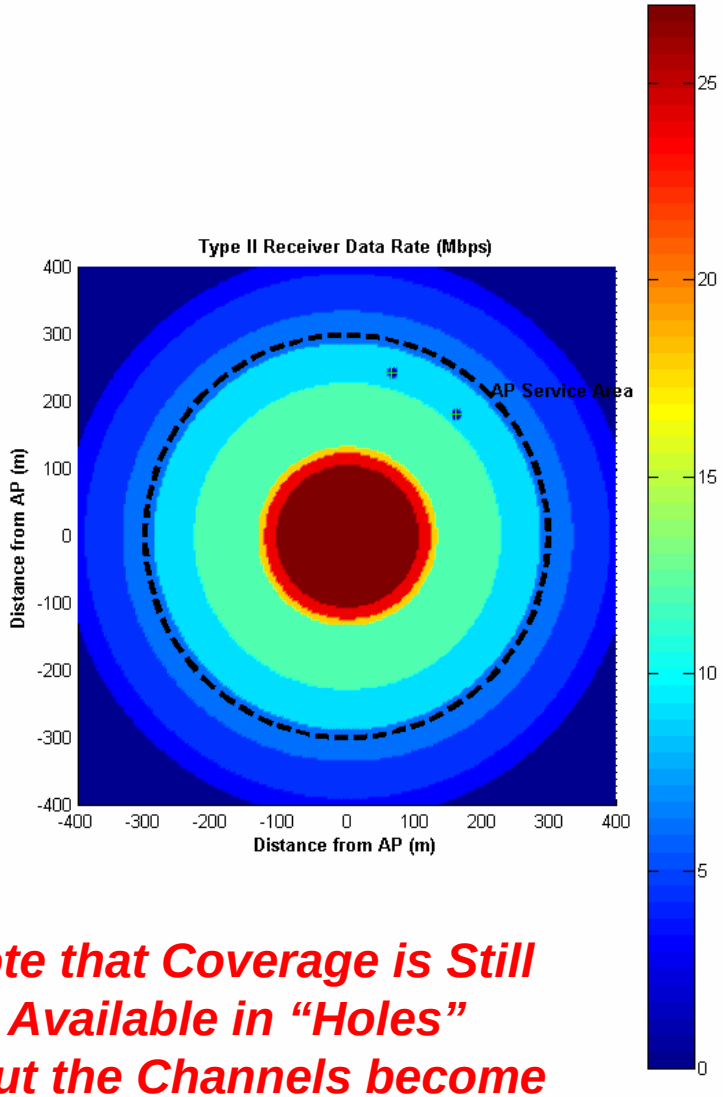
Data Rate (Mbps)	Desired Range (m)
3	422
6	335
9	287
12	228
18	133
24	123
27	106

Data Rate (Mbps)	Interference Range (m)
3	106
6	97
9	87
12	77
18	43
24	55
27	69

Values are to scale

2 Adjacent Units within AP Coverage – Unmanaged Spectrum

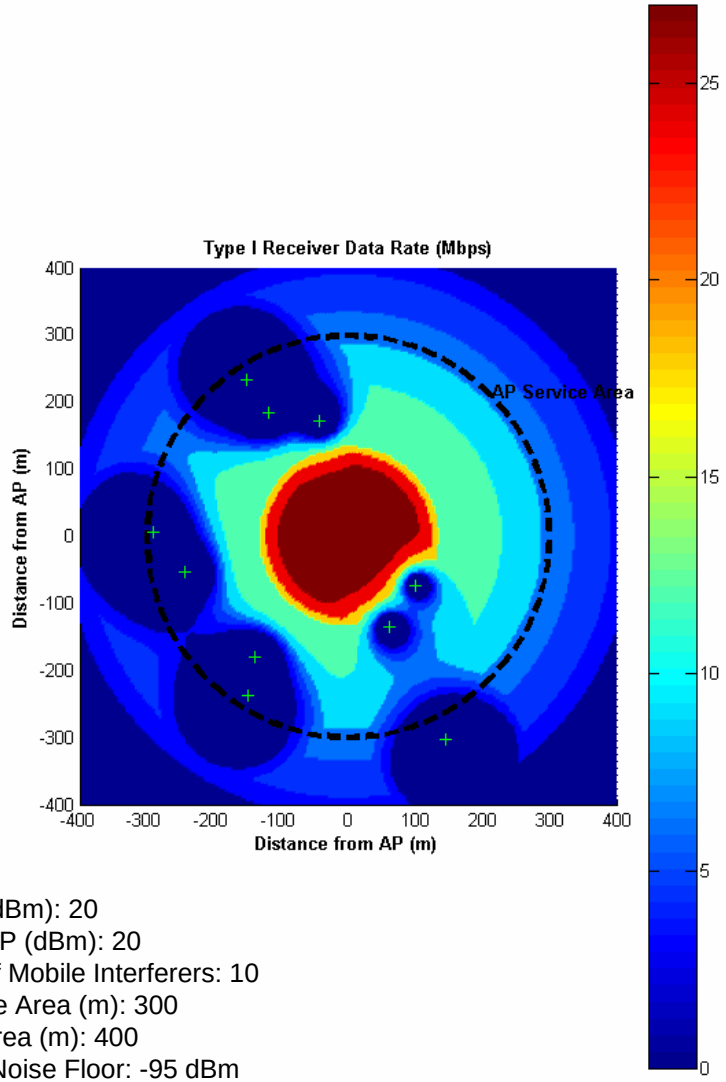


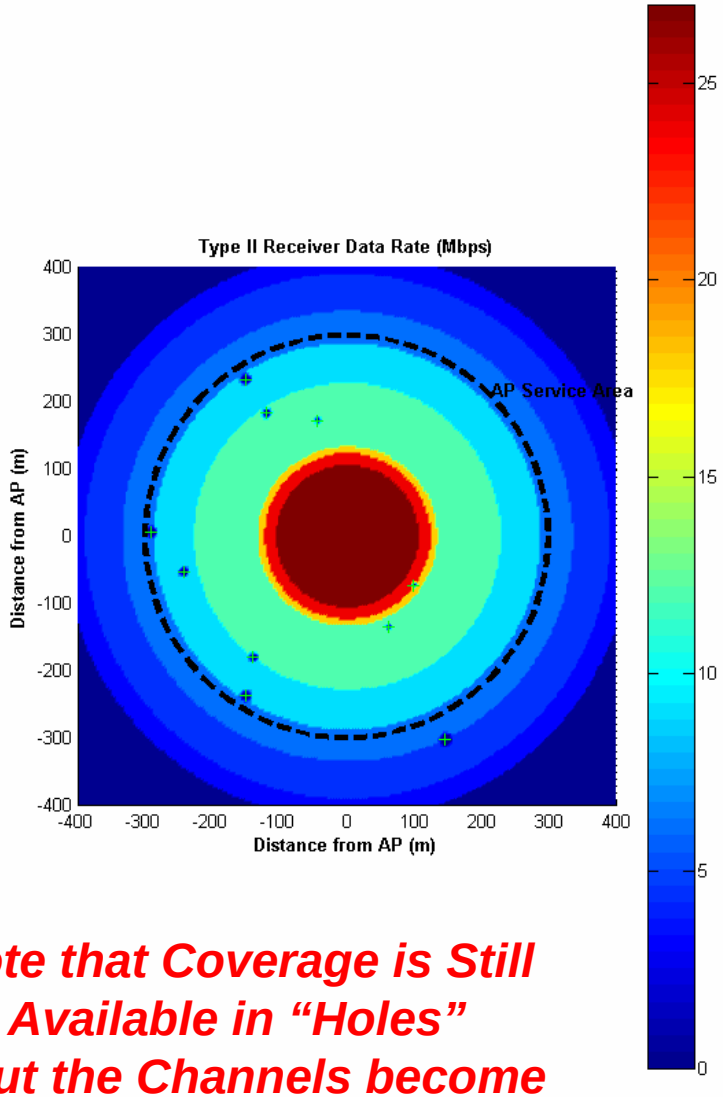


AP ERP (dBm): 20
Mobile ERP (dBm): 20
Number of Mobile Interferers: 2
AP Service Area (m): 300
Domain Area (m): 400
Receiver Noise Floor: -95 dBm
AP Path Loss Exponent: 2/3
Mobile Path Loss Exponent: 2/3
Two Slope Model, R_{bp} =100 m, S_2=3

Note that Coverage is Still Available in "Holes" - But the Channels become Time Shared through DCF

10 Adjacent Units within AP Coverage – Unmanaged Spectrum

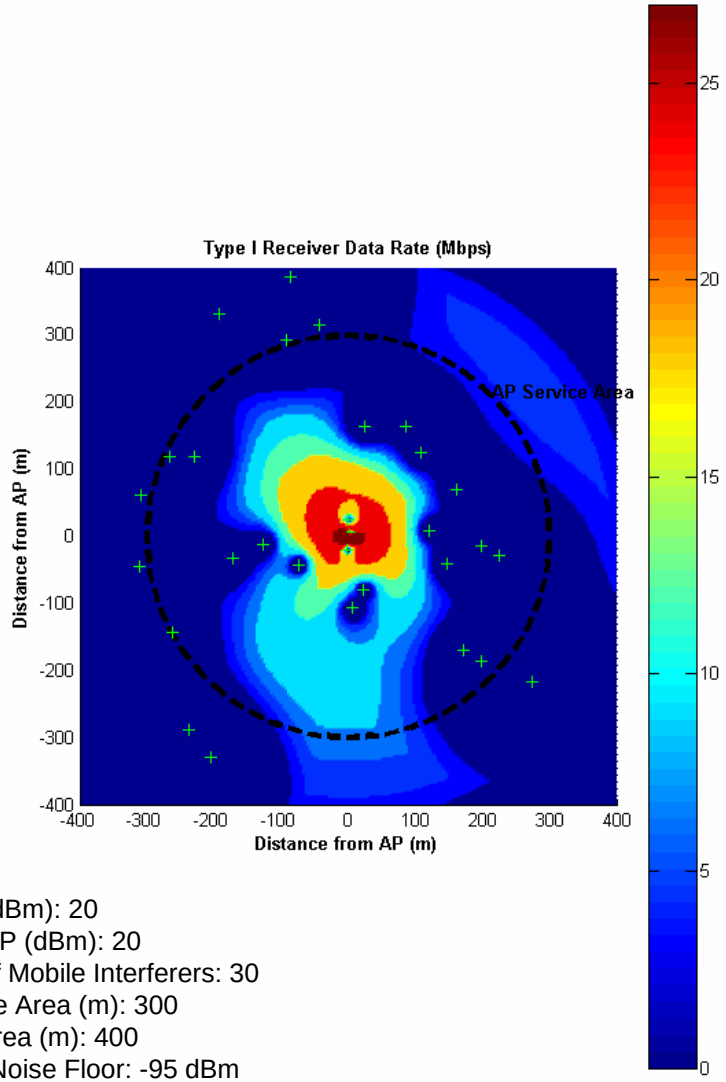


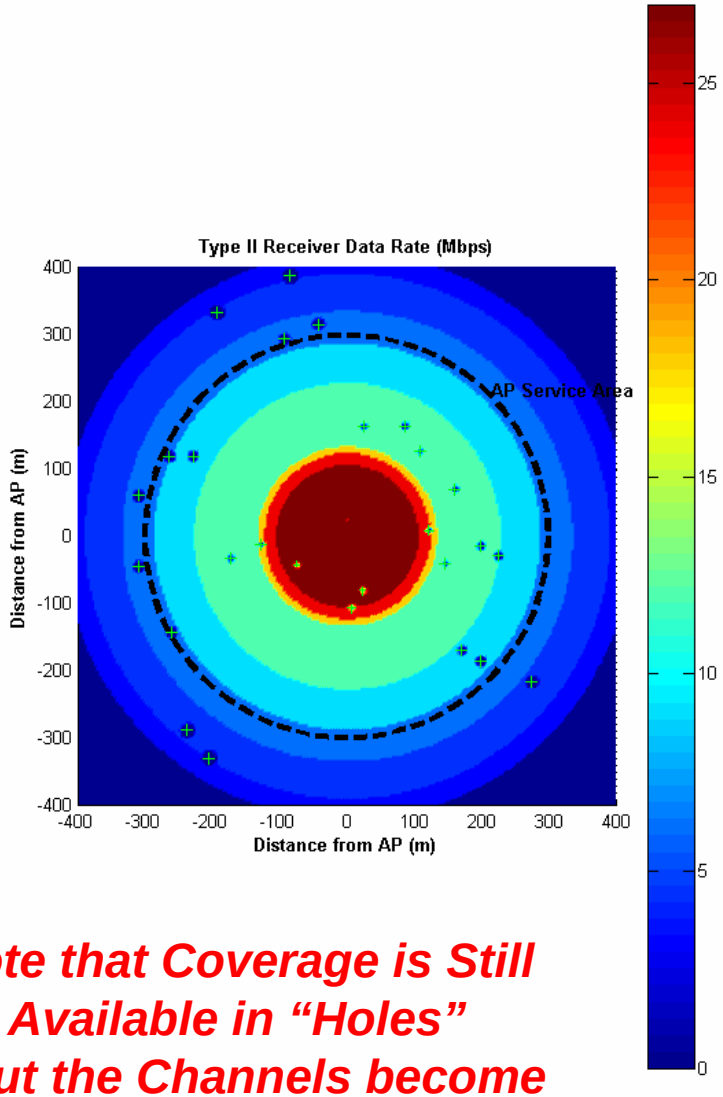


AP ERP (dBm): 20
Mobile ERP (dBm): 20
Number of Mobile Interferers: 10
AP Service Area (m): 300
Domain Area (m): 400
Receiver Noise Floor: -95 dBm
AP Path Loss Exponent: 2/3
Mobile Path Loss Exponent: 2/3
Two Slope Model, R_{bp} =100 m, S_2=3

Note that Coverage is Still Available in "Holes" - But the Channels become Time Shared through DCF

30 Adjacent Units within AP Coverage – Unmanaged Spectrum

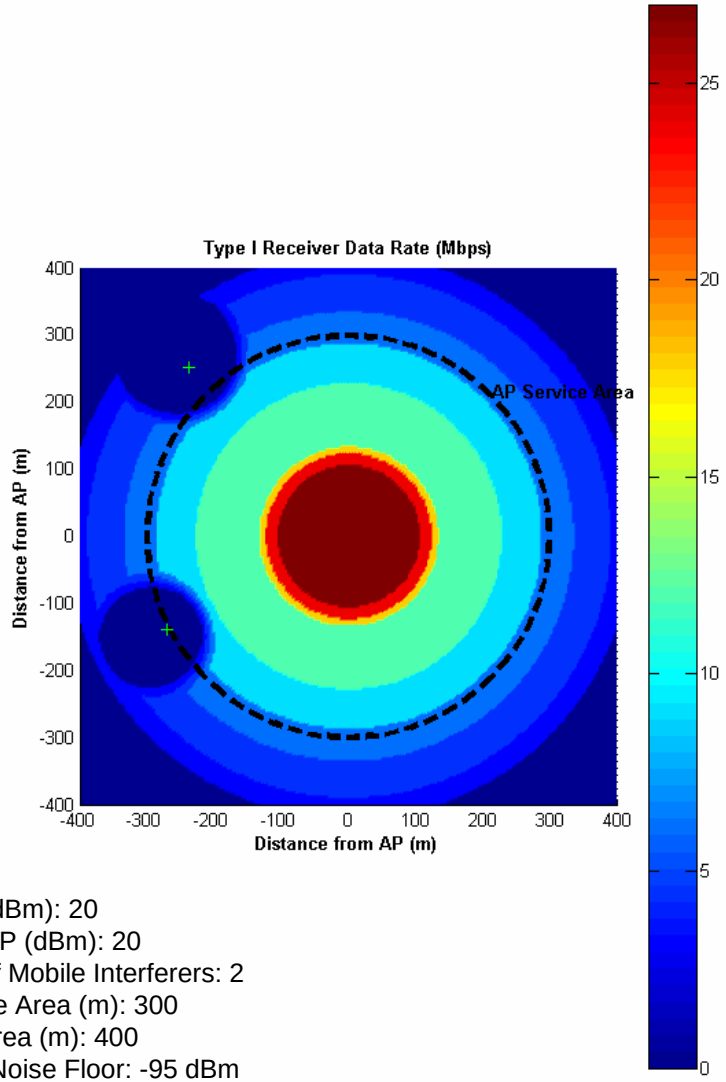


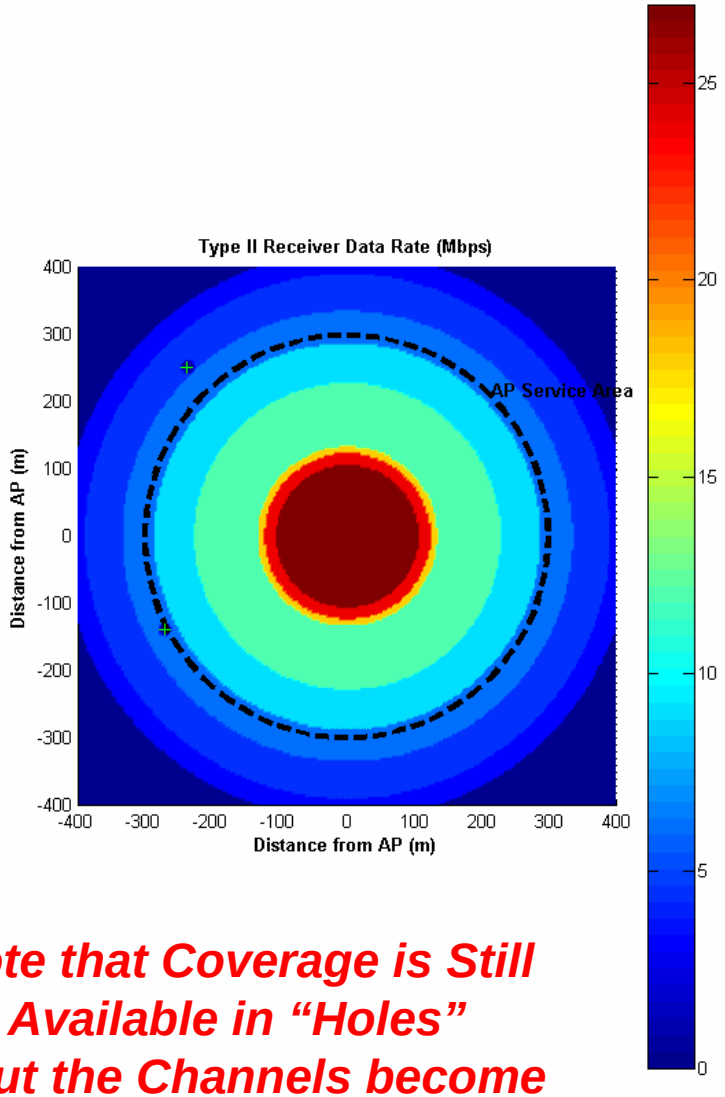


AP ERP (dBm): 20
Mobile ERP (dBm): 20
Number of Mobile Interferers: 30
AP Service Area (m): 300
Domain Area (m): 400
Receiver Noise Floor: -95 dBm
AP Path Loss Exponent: 2/3
Mobile Path Loss Exponent: 2/3
Two Slope Model, R_{bp} =100 m, S_2=3

Note that Coverage is Still Available in "Holes" - But the Channels become Time Shared through DCF

2 Adjacent Units Outside AP Coverage – Managed Spectrum





AP ERP (dBm): 20
Mobile ERP (dBm): 20
Number of Mobile Interferers: 2
AP Service Area (m): 300
Domain Area (m): 400
Receiver Noise Floor: -95 dBm
AP Path Loss Exponent: 2/3
Mobile Path Loss Exponent: 2/3
Two Slope Model, R_{bp} =100 m, S_2=3

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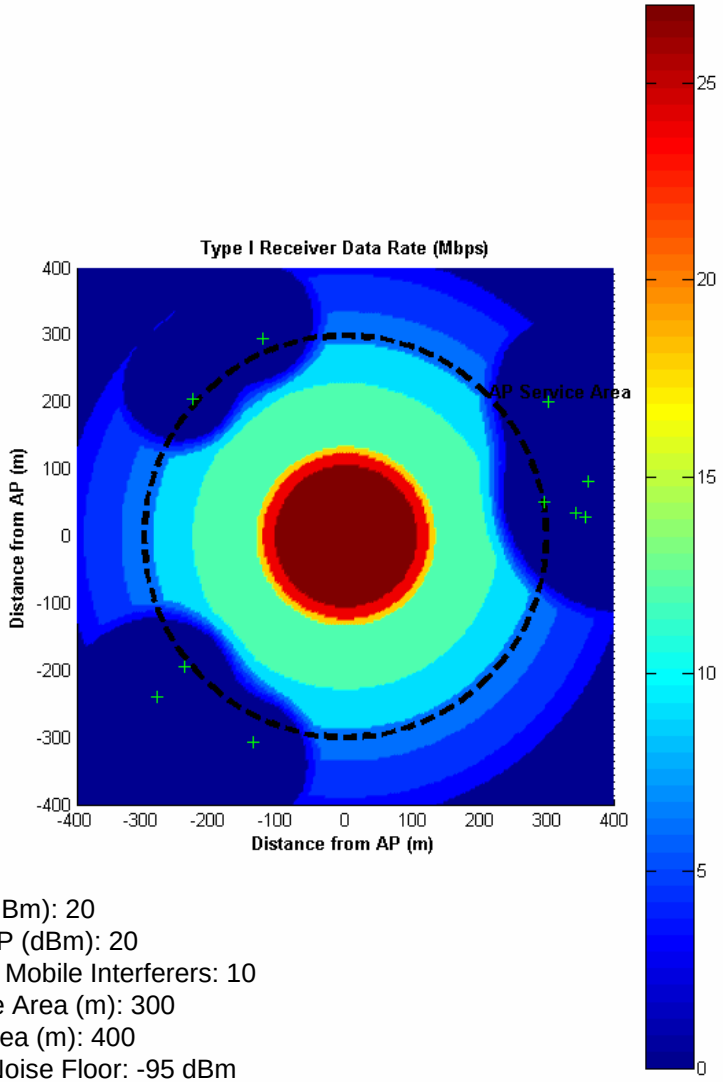
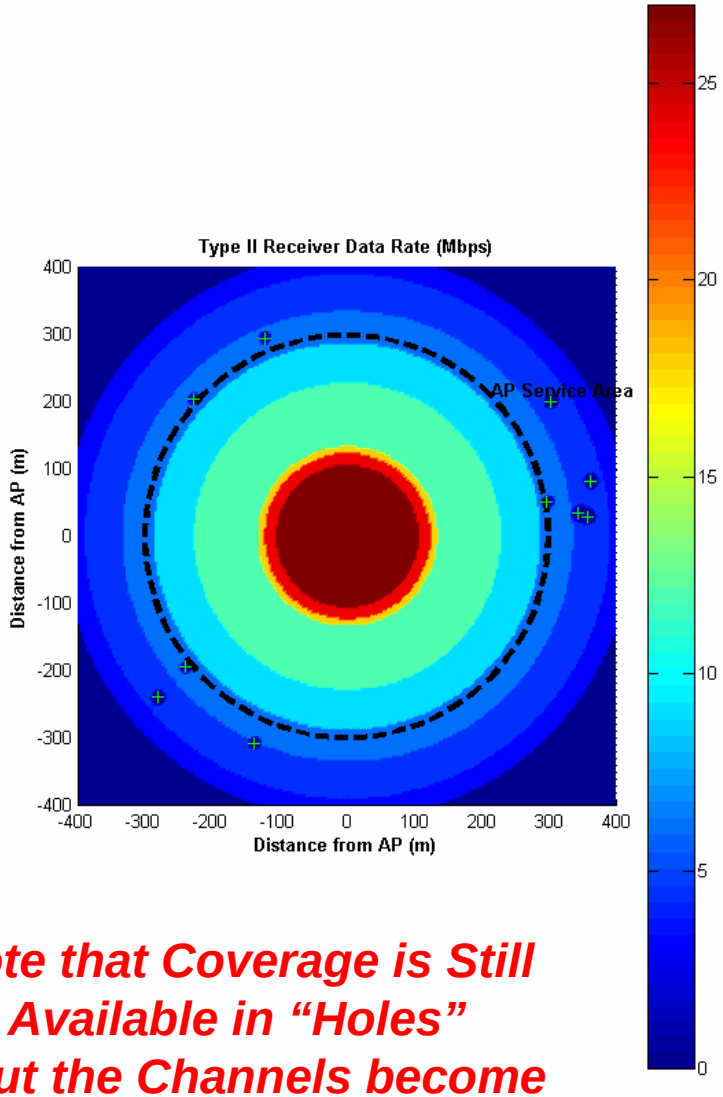
10 Adjacent Units Outside AP Coverage – Managed Spectrum





AP ERP (dBm): 20
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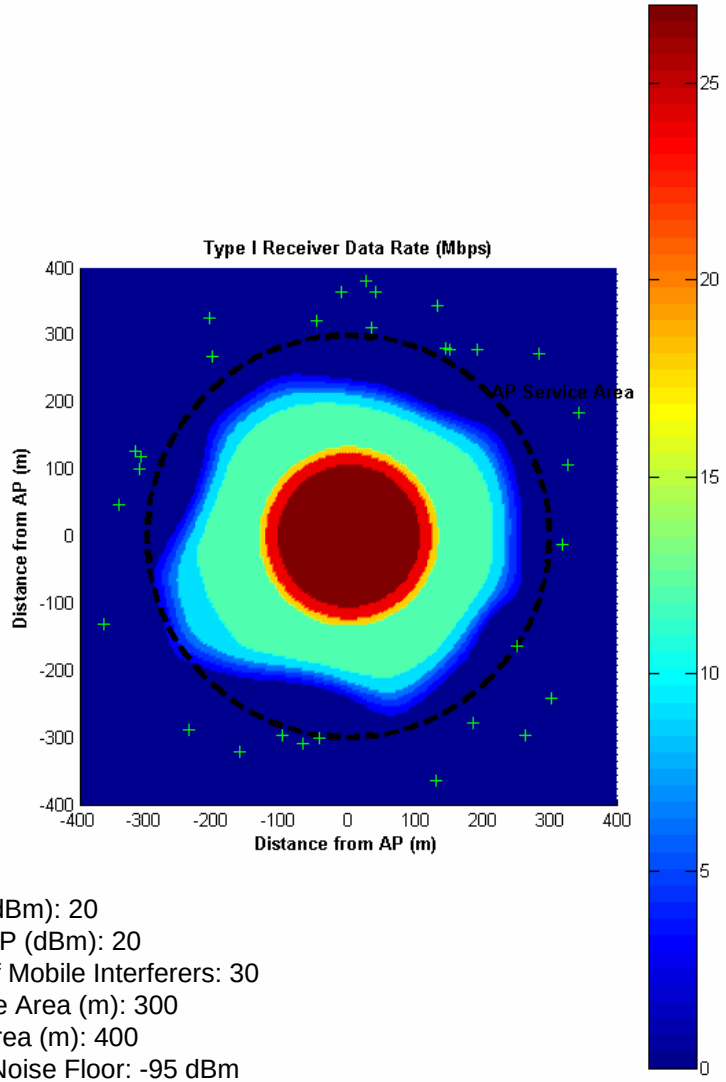
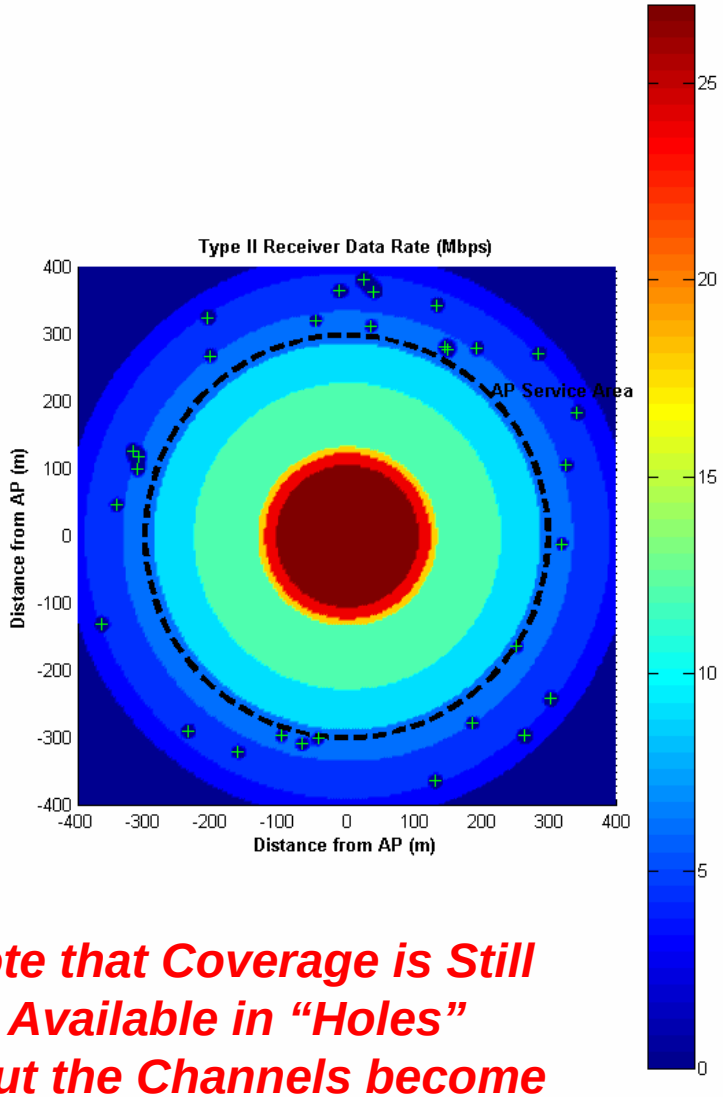
Note that Coverage is Still Available in "Holes" - But the Channels become Time Shared through DCF

30 Adjacent Units Outside AP Coverage – Managed Spectrum





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Note that Coverage is Still Available in "Holes" - But the Channels become Time Shared through DCF

Contact for Further Questions:
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ohara@syrres.com